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GB 1599727 GB 1432818
GB 1525334 GB 1317152
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(54) Wide bandwidth surface acoustic wave vibration sensor

(57) A vibration sensor comprising a cantilever flexible beam (3) bearing on one surface a surface acoustic wave structure (1,2), the beam being supported for a portion of its length from one end on a rigid support member (4) and carrying on its unsupported portion a mass of damping material (5) whereby during flexural vibration of the beam standing waves in the beam due to flexural waves reflected from the unsupported end of the beam are eliminated, the surface acoustic wave structure being located about the position of maximum flexing of the beam during vibration. The surface acoustic wave structure may be a simple delay line or it may include reflectors (7,8) to form a resonant cavity. The free end of the beam may be mass loaded (9).

Fig.1.

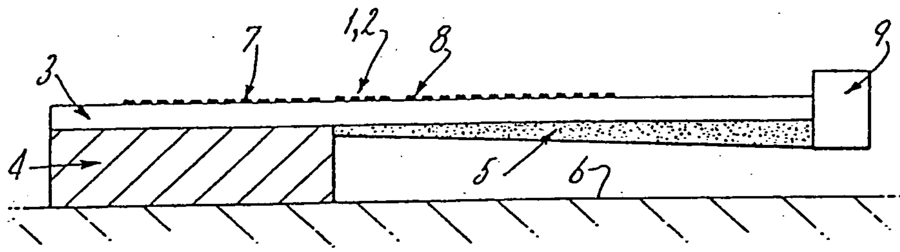

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Fig.1.

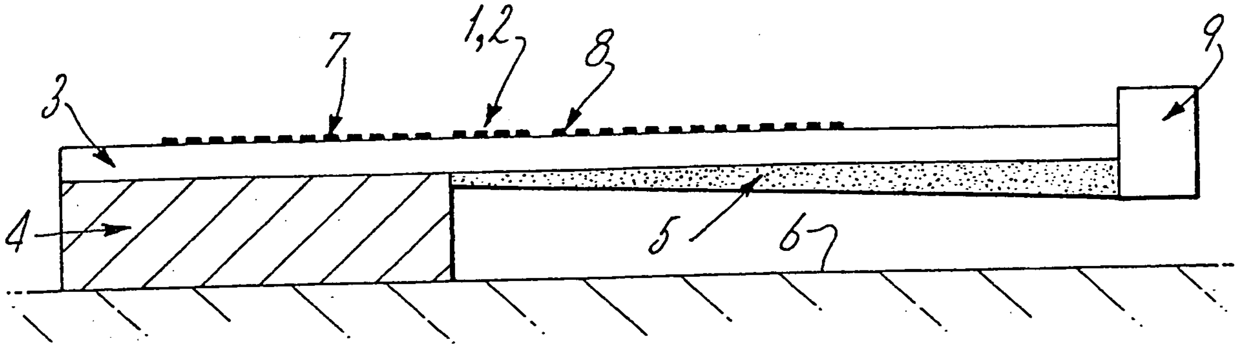
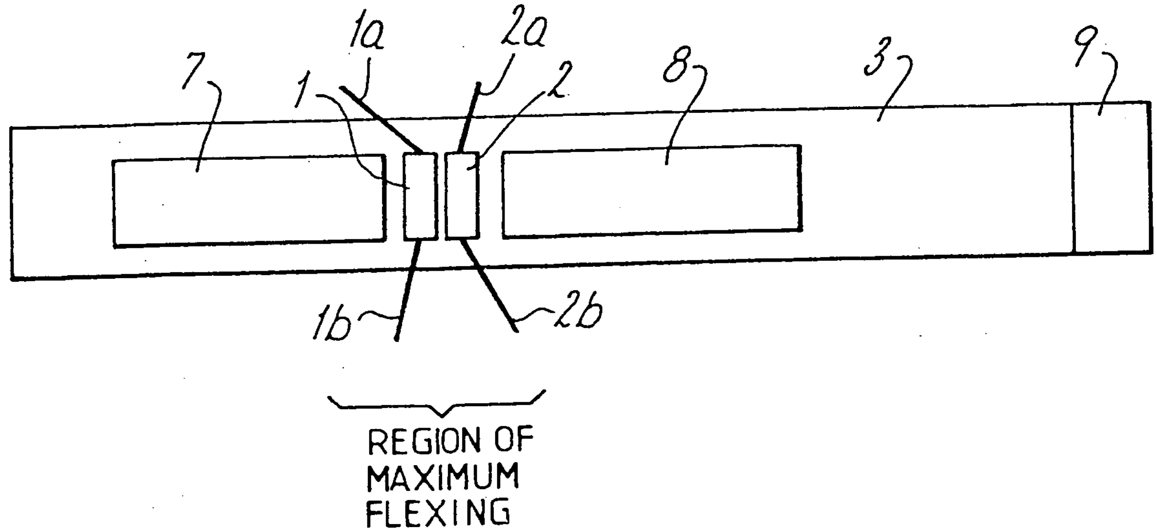


Fig.2.



POOR QUALITY

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Wide bandwidth surface acoustic wave vibration sensor

This invention relates to vibration sensors using surface acoustic wave technology such as may be used for monitoring the performance and condition of bearings in engineering equipment.

It is well known that bearings, e.g. ball or roller bearings, can be monitored in use by detecting and measuring vibration in the bearing. The problem is to provide a compact, rigged form of vibration sensor that can be utilised in situ on a bearing.

According to the present invention there is provided a vibration sensor comprising a flexible beam bearing a surface acoustic wave structure(s), the beam being supported for a portion of its length on a rigid support member and including means for damping its unsupported portion(s) whereby during flexural vibration of the beam standing waves in the beam due to flexural waves are eliminated, the surface acoustic wave structure being located about the position of maximum flexing of the beam during vibration.

An embodiment of the invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 is a plan view of a surface acoustic wave vibration sensor, and

Figure 2 is a side view of the sensor of Figure 1.

The vibration sensor is based on a surface acoustic wave accelerometer mounted on a particular configuration of flexible beam. In the embodiment illustrated surface acoustic wave transducers, e.g. interdigital electrode patterns 1,2 etched in aluminium, are formed on one side of a quartz beam 3. The beam is rigidly supported for a portion member 4, e.g. a quartz spacer. The unsupported portion of the beam 3 is provided with flexural vibration damping material 5. The transducers 1,2 are located about the position of maximum flexing when the support member 4 is subject to vibration, e.g. by attachment to a vibrating body 6 such as the housing of bearing. This would normally be above the point at which the unsupported portion of the beam commences.

The transducers 1,2 are connected via leads 1a, 1b, 2a, 2b to a circuit (not shown) in which the resonator forms, together with an amplifier, an oscillator maintaining loop. The oscillator output is thus in the form of a carrier frequency modulated by a vibration frequency.

Whilst a simple two transducer delay line may suffice it may be beneficial to incorporate acoustic wave reflectors 7,8 on either side of the resonator. These have the effect of turning the acoustic wave structure into the equivalent of a resonant cavity. Further, it may be desirable to mass load the unsupported end of the beam 3, with a weight 9. The choice of dimensions, loading etc is governed by range of vibration frequencies which it is desired to monitor. The sensor is constructed so as to respond to applied vibration with a minimum variation in sensitivity over a frequency band up to, and exceeding by many octaves, the first flexural resonance frequency. This is achieved by ensuring:-

1) that the sensor active region (the surface acoustic wave delay line or resonator cavity) is shorter than one quarter of the wavelength of the upper frequency of interest, and

2) that the beam is damped for flexural vibration such that virtually no flexural waves are reflected from the unsupported end of the beam.

A characteristic of a sensor such as has been described is that it is also sensitive to temperature changes. For example, m when used to monitor the performance of a bearing not only will vibration in the bearing impose a modulation on the carrier at the frequency of the vibration, there will also be a long-term variation of the modulated carrier in accordance with any temperature variation of the bearing. This is important because usually deterioration in a bearing is accompanied by a temperature rise. Thus even when the vibration ceases, e.g. when the maching running is stopped, the residual temperature change is detectable until the bearing has cooled down to ambient temperature. Differential filtering of the oscillator frequency can be used to detect separately the low frequency (down to d.c. component imposed on the carrier by temperature change and the relatively high frequency modulation of the carrier due to vibration.

CLAIMS

1. A vibration sensor comprising a flexible beam bearing a surface acoustic wave structure(s), the beam being supported for a portion of its length on a rigid support member and including means for damping its unsupported portion(s) whereby during flexural vibration of the beam standing waves in the beam due to flexural waves are eliminated, the surface acoustic wave structure being located about the position of maximum flexing of the beam during vibration.

2. A sensor according to claim 1 wherein the surface acoustic wave structure is configured as a delay line.

3. A sensor according to claim 1 wherein the surface acoustic wave structure includes two acoustic wave reflectors, one on either side of the pair of transducers, to form with the transducers a resonant cavity.

4. A sensor according to claim 1, 2 or 3 including mass loading of the unsupported end of the beam.

5. A sensor according to any preceding claim wherein the beam is quartz.

6. A sensor according to any preceding claim wherein the support member is quartz.

7. A vibration sensor substantially as described with reference to the accompanying drawings.

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